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CONTRACTORS WILL BE HELD LIABLE FOR TECHS WHO LEAK REFRIGERANTS

by Thomas A. Mahoney

WASHINGTON — Contractors whose service technicians violate the July 1 no-venting rule for CFC and HCFC refrigerants will find themselves liable for potentially steep fines, as will the owners of the air conditioning and refrigeration equipment.

An Environmental Protection Agency (EPA) official said the agency will go after anyone who would feel the sting for violating the no-venting rule, which takes effect July 1.

"What we want to do, quite frankly, is to make as many people as possible liable, just to put on the enforcement pressure," said Craig Haas, an EPA enforcement official.

In expanding liability, EPA wants to ensure that "everybody has an incentive to play right," he said. "We wouldn't want a contractor to be able to say, 'It was just that one technician [who violated the rule].' "

After a series of meetings with industry representatives, EPA expects to send its proposed recycling rules to the White House for review this month.

In a phone interview with *The News*, Haas summarized remarks he made to a contractor-sponsored meeting last month in North Carolina.

The agency is planning for a "significant increase in enforcement personnel," he said.

Although the agency will not be 100% staffed with inspectors by July 1, "We will have them ready. We will have the capacity to respond to significant tips."

Citing the Clean Air Act amendments which underlie the proposed rule, Haas said:

- The maximum fine is $25,000 per day per violation. Each kilogram (kg) of CFC illegally imported or manufactured would be a separate violation. The same per-kg violation could apply to venting.
- After July 1, a leaky mechanical system is not, in itself, a violation. However, once it is serviced, any significant, intentional venting would make the parties involved liable.
- Depending on the severity of the offense, violators will face one of three courts: an EPA administrative court; a federal civil court; or a federal criminal court.
- Enforcement will be accomplished by EPA. "But the states could, if they express an interest, do inspections for us."
- "Field citations" will be issued to technicians who use non-certified recovery-recycling equipment. "It's like a traffic ticket," Haas said.
- To date, the agency has not "targeted" certain types of equipment — chillers, rooftops, etc. — for immediate inspection. "There will be a certain number of random inspections." Otherwise, inspections will based on "tips and suspicions of violations."

Regarding the payment of bounties for those who report intentional venting, EPA representatives have issued conflicting information.

During a local Air Conditioning Contractors of America conference in Lansing, Mich., a Region V EPA spokesperson said a $10,000 bounty would not be imposed.

The spokesperson said the proposed bounty was never more than a proposal. "Those who invest in the recovery equipment will probably turn in anyone who is breaking the law [anyway]," she said.

But the Washington EPA press office said the enforcement provision is part of the Clean Air Act, and that no decision has been made on whether it will be applied.

ACCA spells out formula to end industry skirmishes

HONOLULU — Consumers benefit most when all the entities that provide their comfort — contractors, wholesalers, manufacturers, and utilities — work together.

To put it mildly, that's not always the case.

However, while there have been continuing skirmishes among these four entities, no one has ever described how the whole thing *should* work. That is, until now.

A model document, introduced at the Air Conditioning Contractors of America's annual meeting by Honeywell's John Ehlen (chairman of ACCA's Associate Member Task Team), defines the best-case relationship — "partnering" — of each faction with the others.

Defined, for example, are the relationships between:

- Contractor-utility; utility-contractor;

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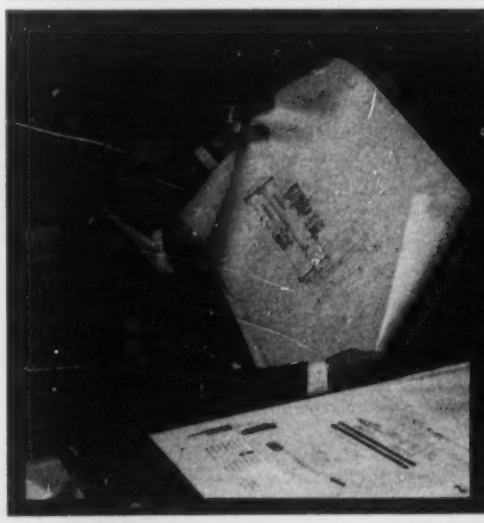

Details, details

FEATURED IN OUR "COOLING SHOWCASE" issue next week will be the step-by-step replacement of an old chiller with one using R-134a for a downtown Atlanta office building. Carlin O. Hodges, vice president service operations for Cherokee Heating and Air Conditioning, looks over plans that helped keep tenants from even knowing the work was underway.

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Why compressors fail mechanically

(Continued from Page 3)

at all temperatures.

Sugar and water are miscible until the water gets saturated.

R-22 and R-502 are not miscible under all conditions. In the same vessel, they sometimes separate into two layers. The upper layer will be an oil-rich mixture of refrigerant and oil. The bottom will be a layer of refrigerant-rich mixture of oil and refrigerant.

This difference between R-12 and -502 and R-22 may surprise service technicians who are used to working with only R-12. In any event, the driving force to cause refrigerants to mix with oil in the compressor is the difference in pressure.

Even a solid such as steel can be melted and vaporized and, consequently, can have a vapor pressure chart. We're not very familiar with it, but it exists.

Oil has a vapor pressure system of its own. At 350°F, it has a vapor pressure of about 150 microns. At 70°, its vapor pressure is about 0.01 micron.

Now consider that the vapor pressure of R-22 at 70° is about 120 psig. Since 1 psig = 50,000 microns, 120 psig X 50,000 microns/lb = 6,000,000 microns of refrigerant pressure.

This is some pressure difference: 6,000,000 microns against 0.01 microns for the oil; you can see why the refrigerant moves to the oil so easily and rapidly.

Actually, the refrigerant moves more or less rapidly depending on the percentage of refrigerant in the oil. It moves very rapidly to pure oil, but as the oil becomes mixed with more refrigerant, the vapor pressure of the mixture raises, so that the differential pressure decreases and the migration rate decreases.

Increasing the oil temperature reduces the migration speed, while raising refrigerant temperature increases migration speed.

For example, an idle condensing unit outdoors in the sun is hot, while the evaporator coil indoors may be quite cool; migration is slow.

In cold weather, just the opposite is true. The unit with its oil in the compressor is cold and the evaporator is warm; migration is rapid.

Consider our previous article on flooding. Any flooding action causing cool liquid refrigerant to enter the compressor also causes the oil to cool and absorb more refrigerant.

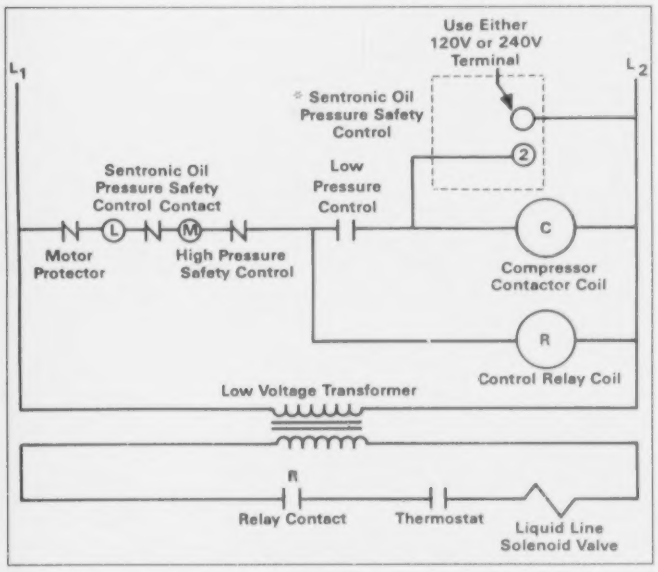

FIGURE 2 — Typical low voltage control circuit.
* May be conventional control.

Lubrication woes

Excess flooding causes poor lubrication of lower crankcase gears. In fact, as described in our previous article, the oil pump can pump a mixture of refrigerant and oil.

But as the mixture leaves the pump, the crankshaft friction boils off some of the liquid, leaving insufficient oil volume to lubricate the connecting rods and rear main bearings.

This results in an ever-increasing wear pattern developing as the mixture gets further from the pump.

The pump may cavitate from severe dilution because the "Freon" boils at the pump entrance blocking oil flow. This commonly causes what are called "nuisance trips" of the oil pressure safety switch.

The switch is warning of a problem when it trips; it should never be considered a nuisance trip. Any flooding or migration problem must be corrected or a premature compressor failure will occur.

A major problem with migration is that large quantities of liquid refrigerant may be stratified near pure liquid in the crankcase during the off cycle. Upon start-up, even a small drop in suction pressure causes a violent explosion of this refrigerant, which can clear oil and liquid out of the crankcase in a few seconds.

In addition, severe slugging may result. (This will be covered in a separate article.)

So, how can these problems be prevented?

Limit refrigerant charge

The first and most important criteria of design to stop excess dilution damage is to limit the refrigerant charge in the system.

If the refrigerant charge can be kept down to about two to three time's the oil charge (by weight), damage is unlikely to occur because the worst-possible mixture in the crankcase would be 75% refrigerant, 25% oil.

Small, self-contained systems usually can survive with this mixture. But central-station, two-piece systems, and almost any system with a liquid receiver, probably could not stay within this ratio.

To limit refrigerant charge, you could:

- Limit liquid line size;
- Eliminate receivers if possible;
- Keep the refrigerant charge as low as possible;
- Never overcharge a system;
- Use the smallest-practical lines and components; and
- Use crankcase heaters.

But remember, crankcase heaters have limitations. They must be kept to a reasonable low amperage to prevent oil carbonization and overheating.

The wattage is so low that in low ambient conditions (from 50° to 0°), they are of little value in outdoor applications. Also, refrigerant enters the oil rapidly, but heat drives it out slowly. Crankcase heaters must be on 12 to 24 hours to be effective.

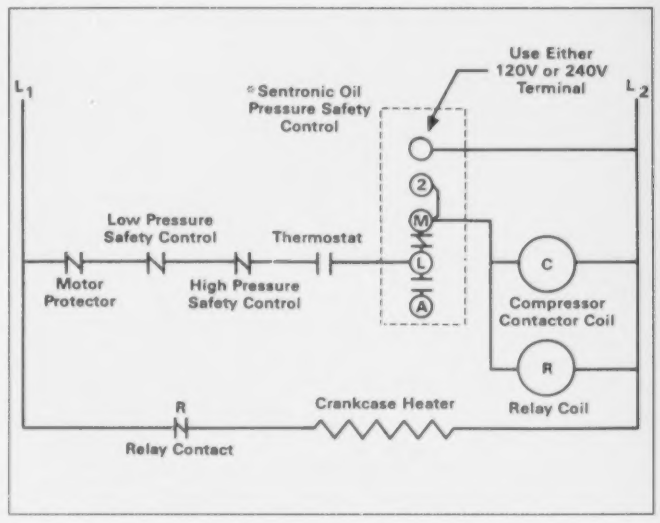

FIGURE 3 — Typical crankcase heater control circuit.
* May be conventional control.

Considered the best method to prevent migration is the use of a **pump-down system,** in which the cycle control opens and closes a liquid line solenoid valve.

When the cycle ends, the control closes the solenoid valve and allows the compressor to keep running, evacuating the evaporator, suction line, and compressor crankcase to a reasonable low pressure.

A low pressure switch turns the compressor off.

The reverse happens when the solenoid valve is reopened. Figures 1, 2, and 3 show one compressor manufacturer's ideas of typical pump down and crankcase heater wiring diagrams. (While a relay on the crankcase heater circuit is shown, most air conditioning systems can operate without this relay.)

Sometimes a relay is added to prevent recycling until the cycle control opens the solenoid valve. It is hoped that with this system, not enough liquid will seep through any leaking valves to do any harm.

I prefer to count on the valves not leaking and use the recycling pump-down system. Usually a combination of design and devices, such as crankcase heaters and pump-down systems, are used. Anything is helpful.

The next article will be on slugging, which can be caused by either flooding or migrating refrigerant.

Dick Snyder knows air conditioning and refrigeration equipment. He has studied equipment service, both as a technician and a manufacturer, and has taught service concepts to thousands of contractor and wholesaler personnel. He is currently associated with Young Supply Co., Detroit, and now writes exclusively for *The News.*

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HOUSING AND CONSTRUCTION

After braving its worst year since the end of World War II, the nation's housing industry is promising to pull the U.S. up from a lackluster end to the recession.

The lowest mortgage interest rates in nearly two decades and an upward stirring of consumer confidence are expected to overcome — at least, to some extent — a continuing builder loan credit crunch to produce a welcome 18% surge in new home starts this year.

The forecast of 1,200,000 new home starts in 1992 does not include any election-year gimmicks. If they do occur, they'll probably be too little and too late. Home building, along with existing home sales and associated industries, accounts for about 20% of the nation's gross national product (gnp) and should be able to pull the economy out of the doldrums.

But, first, a look at what happened last year.

Total private housing starts in 1991 amounted to 1,014,700 units, down 14.9% from the 1,192,700 units started in the previous year. Last year's total was the latest in a steady decline of nearly 800,000 units since 1986, and was the lowest total since 1946.

Single-family home starts, where the trade-up segment is softening, totaled 841,600 units last year, a decline of 5.9% from the 894,800 single-family homes started in 1990. It was the second year in a row that single-family home construction has fallen below the 1-million mark since 1982.

Multi-family starts in 1991 added up to a dismal 173,100 units, down 41.9% from the year-previous total of 297,900 units. This market, which recorded 626,000 starts in 1986, was hit by massive overbuilding in the mid-1980s, a vacancy rate still in the 11% range, and tight credit.

Again, in 1991, declines were registered in all four regions.

Housing starts in the Northeast, at 112,900 units in 1991, were down 14% from the 131,800 starts recorded in 1990. Last year's decline followed a 26.4% drop in 1990 and an almost free fall of 61.5% from the 1986 total of 293,500 units. The mini-boom of the years 1985 through 1987 has given way to falling property values and a virtual gridlock among buyers and sellers.

The smallest decline — 7.7% — came in the Midwest. The 1991 total of 233,800 starts was down from the year-previous total of 253,200 starts. Labeled the "rust belt" in years past because of difficulties in the manufacturing and agriculture industries, 1991 was the first year since 1986 that new home starts fell below 250,000 units. The drop since 1986 was 20.9%, the lowest of all regions.

New home starts in the South, which still accounts for nearly 41% of the total housing market, totaled 414,300 units in 1991, down 13.6% from the 479,300 new home starts recorded in 1990. In 1983, the South accounted for 55% of the nation's new home starts but, since 1986, starts in that region have declined by 43.5%.

New home construction in the West, at 253,700 units in 1991, was down 22.9% from the year-previous total of 328,900 units. Hampered by high home prices and, within the last year, by tight credit, the West has dropped by 47.5% from the 1986 peak of 483,000 units.

A survey of home builders at the NAHB convention in late January revealed that consumer confidence still is their number one problem. It was followed by land cost and the difficulty in getting construction loans.

Consumer confidence is largely a localized problem that's obviously more pronounced in areas where there have been plant closings or significant layoffs. There were indications early in 1992 that consumer confidence is on the rise, if only slightly.

Credit for ADC (acquisition-development-construction) loans has become a double-edged problem for builders. The collapse of many thrift institutions, where more than half of builders arranged for ADC financing, has reduced this source to about 30%.

Some 490 thrifts have been taken over by the federal government's Resolution Trust Corp. Some were merged or sold and 220 were held under RTC conservatorship or receivership. Some estimate it will take $200 billion to clean up the mess. Of the 2,945 thrift institutions before reform, 328 failed in 1989, 200 in 1990, and another 168 in 1991.

Commercial banks picked up much of the mortgage loan originations but, for builders, it was a different story. Banking reforms aimed at deficiencies in bank real estate lending, and heightened scrutiny by examiners, banks became much more conservative about construction loans.

Builders, particularly those involved in multi-family projects, reported they had difficulty obtaining loans from thrifts and banks where they had established credit records. Multi-family builders reported it was almost impossible to get money from institutions where they weren't known.

Looking ahead, NAHB sees better times. It forecasts that total starts in 1993 will amount to 1,424,000 units and, in 1994, starts will total 1.598,000 units.

Interest rates

Interest rates for fixed-rate home mortgages, which had soared to 13.8% as late as 1984 and held in the 10.5% to 10.75% range from 1987 to late 1990, dropped to 8.7% in late 1991. The drop continued to 8.23% early in 1992, then edged upward to 8.78% as billions of dollars worth of federal deficit-financing bonds hit the market.

Adjustable-rate mortgages (ARMs), which in 1984 seemed a bargain at 11.5%, also dropped to 8.36% in late 1990 and, by October, 1991, had slipped to 6.71%. They accounted for 23% of home mortgage originations at that time.

It appeared — at least from the point of view of sales — that consumers were sitting on their hands in the face of the lowest mortgage interest rates in nearly two decades. There was no corresponding spurt in new or existing home sales.

But there was plenty of action by those who had purchased mortgages at high rates in prior years. Even though refinancing accounted for only 35% of residential mortgage originations for the full year of 1991, it accounted for 65% of loan originations in the last three months of the year. Refinancing is expected to account for nearly 80% of mortgage originations in 1992.

While there appears to be plenty of money available for home mortgages, tighter credit restrictions are being applied. For example, banks and thrifts are telling refinance applicants that, if they don't have at least a 20% equity in their property, they needn't bother applying.

A relatively new phenomenon, the sale of property by auction, has sprung up in recent years. In 1987, auction sales totaled $80.7 million, according to Kennedy-Wilson, Inc. In 1991, auction sales totaled $796.2 million, an increase of 191% over the 1990 total of $398.5 million.

Heavily concentrated in California and the Northeast, clients include Resolution Trust Corp., large developers, financial institutions, syndicators, and industry. Types of property (with percent of total volume in parentheses) include: condominiums (38.1%); single-family homes (30.7%); residential lots (9%); commercial income properties (19.4%); land (2.5%); and mobile homes (0.3%).

It appeared — at least from the point of view of sales — that consumers were sitting on their hands in the face of the lowest mortgage interest rates in nearly two decades.

1992 forecast

It would appear that the long-suffering U.S. new home market hit bottom in 1991 — at least as far as single-family starts are concerned. But it would be a mistake to expect a sharp rebound like the nearly 700,000-unit increase in 1983 after the recession a year earlier.

Although credit availability, zoning problems, and even code compliance problems remain, we're confident of an upturn in new home starts. And while there is some pent-up demand in the single-family sector, it isn't nearly as strong as in the periods following prior recessions.

On balance, then, we expect total new home starts in 1992 of 1,200,000 units, an increase of 18.3% over the 1991 total of 1,014,700 starts.

Most of the increase will come from single-family home starts, which we expect will total 1 million units this year. That would be an 18.8% increase. We expect multi-family home starts to increase by 15.5% to 200,000 units this year, even though some would have us believe that this sector has not yet reached bottom.

NAHB, which researches the new home market as well as anyone, is more conservative. It is forecasting a new home start total of 1,185,000 for 1992, 985,000 single-family starts and 200,000 multi-family starts.

Looking ahead, NAHB sees better times. It forecasts that total starts in 1993 will amount to 1,424,000 units and, in 1994, starts will total 1.598,000 units.

The top 20

The top 20 single-family home markets for the first 10 months on 1991, as compiled by NAHB, include the number of building permits pulled for that period:

Atlanta 18,550; Washington, D.C. 12,710; Phoenix 11,870; Riverside-San Bernardino, Calif. 11,290; Minneapolis-St. Paul 10,450; Dallas 9,650; Detroit 9,590; Las Vegas 9,160; Houston 8,760; Philadelphia 8,280; Baltimore 8,050; Chicago 7,840; Orlando, Fla. 7,630; Tampa-St. Petersburg, Fla. 6,660; Sacramento, Calif. 6,590; Los Angeles-Long Beach 6,540; St. Louis 6,330; Seattle 6,090; Charlotte-Gastonia, N.C. 5,910; and Kansas City, Mo. 5,700.

The top 20 multi-family markets include:

Los Angeles-Long Beach 7,510; Las Vegas 5,100; Houston 3,630; Orlando, Fla. 3,440; New York 3,210; Seattle 2,930; Miami-Hialeah 2,870; Honolulu 2,810; Chicago 2,810; Riverside-San Bernardino, Calif. 2,600; Washington, D.C. 2,580; Oakland, Calif. 2,520; Anaheim-Santa Ana, Calif. 2,500; Detroit 2,450; Tampa-St. Petersburg, Fla. 2,430; San Diego 2,340; Milwaukee 2,290; Columbus, Ohio 2,110; Cincinnati, Ohio 2,110; Dallas, 2,080; and West Palm Beach-Boca Raton, Fla. 2,080.

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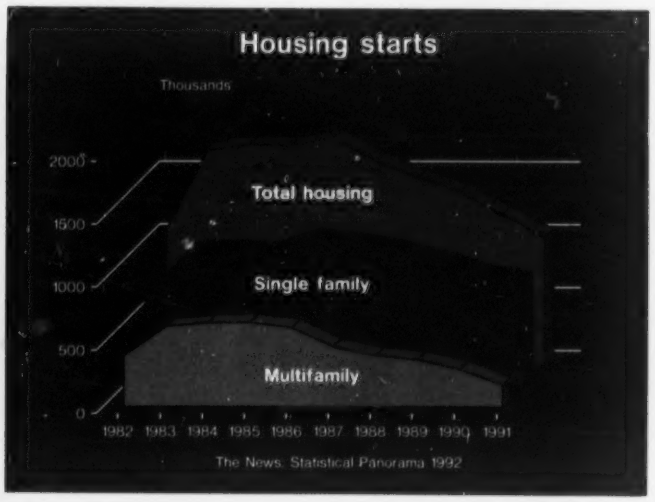
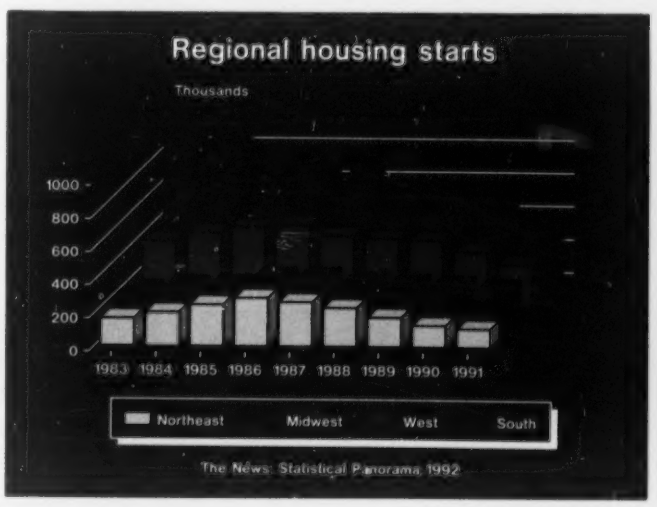




LABOR

By all measures, 1991 was a poor year for the construction industry, a fact that was reflected in a lighter-than-normal load of collective bargaining agreements negotiated by union labor and employing contractors, according to the Construction Labor Research Council (CLRC).

Construction accounted for almost half of the decline in employment in the total economy, CLRC reported. The unemployment rate among construction workers ranged between 14% and 16%, up from 11% in 1990 and at its highest level since 1983.

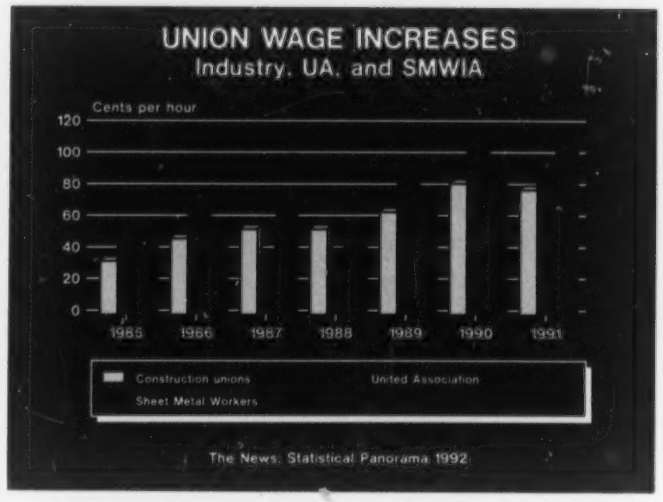
Settlements in both the first and second years of multi-year contracts were less than for 1990, reflecting a reversal of increasingly larger settlements in recent years, said CLRC. Contract durations also were shorter, regional differences were less, and craft variations widened.

Contracts negotiated last year resulted in an average first-year wage increase of 79¢/hour, or 3.4%, and 85¢/hour, or 3.6%, for the second year of multi-year contracts. It was the second year since 1982 that first-year settlements have averaged more than 3%.

The first-year settlement level represents a slight drop from the 1990 average of 83¢/hour, or 3.8%. The average for 1989 was 65¢/hour, or 2.9%. And the average for 1988 was 47¢/hour, or 2.2%.

The rise in later-year increases reflects a decline in the number of contracts containing wage freezes, and the virtual disappearance of rollbacks.

"A weak construction market and strong competition appear to have had an impact on bargaining results," said CLRC. "Especially in the Northeast, average increases were below those of the prior year."



Average settlements for the second and third years of 1991 multi-year agreements were down from the 90¢/hour, or 3.8%, negotiated in 1990, and were closer to first-year averages. Close to two-thirds were between 2% and 4%.

Of the average 79¢/hour first-year increase negotiated in 1991, higher wage rates accounted for 48¢. And, following a trend in recent years, a disproportionate part of the total (26¢) was added to health and welfare contributions. These health and welfare contributions increased by about 15% over rates in old agreements in

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HOUSING AND CONSTRUCTION

(Continued from Page 10)

Demographics

The median age of a single-family detached home buyer in 1991 was 35.9 years, while the median age of a first-time home buyer was 31.2 years. The median age of trade-up home buyers was 39.8 years, while the median age of a single-family attached home was also 39.8 years.

In the case of single-family detached homes, 54.2% were bought by a husband and wife with children, 32.6% were bought by childless couples, 10.1% were bought by a single person, 1.5% were bought by a single person with children, and 1.7% were other sales. Of trade-up sales, 60.1% were bought by couples with children, 30% by childless couples, and 6.6% were bought by a single person.

The median income of buyers of single-family detached homes in 1991 was $57,569, up from $52,210 in 1990. The median income of buyers of single-family attached homes in 1991 was $52,703, up from $48,204 in 1990.

The percentage of households with two or more earners that purchased single-family detached homes increased in 1991 to 68% from 59.8% in 1988, and only 45.4% in 1976. Among households purchasing single-family attached homes last year, 54% had two or more earners.

Household formations is a critical measure in determining the longer-term demand for housing. Household formations, at 1.7 million/year in the 1970s, dropped to 1.3 million/year in the 1980s. In the 1990s, however, household formations fall further to 1.1 million/year.

Population growth is another factor. The Bureau of the Census predicts that the nation's population will grow at a rate of 2 million per year in the 1990s. In the first half of the decade, 60% will come from the existing population base and 40% will come from legal and illegal immigration. In the last half of the decade, it will be a 50%-50% split.

From these and from the shifts in age group numbers, it would appear that the average for new home starts in the 1990s will be in the range of 1.3 million units.

Those interested in the multi-family market keep a close eye on the under-25 age group, 84% of whom are renters. This group has declined by 1 million since 1986 and will decline by another million by the end of the decade.

The decline in the under-25 age group probably will be made up, in large measure, by immigrants who are accustomed to renting. This means an average demand for rental housing of about 450,000 units/year during the 1990s. Of these, about 30% will be single-family homes, 30% will be in structures with two to four units, and 40% will be apartment buildings with five or more units.

Looking at the age groups, the under-25 age group will add only 200,000 in the 1990s, the 25- 34-year age group will decline by 3.9 million, the 35- to 54-year age group will increase by 7.3 million, the 55- to 74-year age group will hold relatively steady, and the 75 and over group will increase by 2.8 million.

Other factors

The median price of a new home sold in October, 1991 was $122,500 and the average price was $149,400. Comparable prices in October, 1990 were $121,800 and $157,500. These figures reflect both a stabilization of prices and a shift toward more homes for first-time buyers.

The median price of existing homes sold in October, 1991 was $99,200 and the average was $126,500. Comparable prices in October, 1990 were $92,800 and $115,700.

The National Association of Realtors reported that 3,260,000 existing homes were sold in 1991, down a hair from the 3,329,600 existing homes sold in the previous year. The association expects 1992 sales will total 3,489,000 homes.

Of the 93,683,000 occupied housing units in the U.S., NAHB estimates that 727,000 are cooperatives and 3,204,000 are condominiums. NAHB reported that the condominium market now has an approximate 20% share of new home starts compared to a 40% share in the 1980s, primarily because it was concentrated in the now-distressed Northeast market.

NAHB reported that new home sales in 1991 totaled 500,000 units, the lowest level since 1982. The association expects 1992 new home sales to reach 575,000 units.

Mobile homes

Manufacturer shipments of mobile homes totaled 170,713 units in 1991, an 11.2% decline from the 192,300 mobile homes shipped in the previous year, according to the Manufactured Housing Institute (MHI).

Shipments of these site-delivered homes, popular with retired people and those with moderate incomes, are not counted in the official housing statistics.

In late years, mobile homes have accounted for about 20% of private single-family home starts, down from 36% in recession-ridden 1982. Last year, however, they accounted for only 16.8%.

A moderate recovery in the South in 1992 should push mobile home shipments back up to 190,000 units. Over the longer term, however, a declining pool of first-time home buyers should keep average shipments of mobile homes at about 200,000 units for the rest of the decade.

How existing U.S. homes are heated and cooled

According to the Bureau of the Census, there were 105,661,000 housing units in the U.S. in 1989. Of these, 2,881,000 were seasonal (vacation) homes, and 9,097,000 were vacant. This left 93,683,000 occupied homes. Of these, 59,916,000 (64%) were owner-occupied; 33,767,000 (36%) were occupied by renters.

Of the 93.7 million occupied homes in the U.S. in 1989, a total of 37,554,000 — or 40% — were equipped with central air conditioning. The penetration rises to 44.7% if we consider the 26,789,000 owner-occupied homes with central cooling. Only 10,765,000 renter-occupied homes, or 31.9%, are equipped with central air conditioning.

For the record, the Bureau of the Census also tells us that 612,000 of the 2.9 million seasonal (vacation) homes, and 3,255,000 vacant (for sale or rent) homes are equipped with central air conditioning. That makes a total universe of 41,420,000 central air systems, or 39.2% of all U.S. housing units.

Of the occupied homes, 34,367,000 (91.5%) of the central cooling systems are powered by electricity. Another 3,004,000 homes (8%) are gas-fired absorption systems. And 281,000 are powered by other means.

A 1987 Bureau of the Census study reported that 26,547,000, or 29.2% of the 90,888,000 occupied homes at that time, were equipped with one or more room air conditioners. Another 33,006,000 occupied homes (36.3%) had central air conditioning, and 31,335,000 homes (34.5%) were without any air conditioning.

Regionally, occupied homes without air conditioning ranged from 56.5% in the West, 46.9% in the Northeast, 33% in the Midwest, and only 13.7% in the South. Back in 1970, almost two thirds (64.2%) of occupied U.S. homes were without air conditioning of any kind.

Among the occupied homes in 1989, a total of 50,271,000 (53.7%) were equipped with a warm-air furnace as the main heating equipment, and 13,566,000 homes (14.5%) were heated with hydronic systems.

Heat pumps accounted for 6,875 homes, or 7.3%, and other built-in electric systems (resistance baseboard, ceiling cable) were installed in 6,658,000 (7.1%) of homes.

Floor, wall, or other built-in hot air units without ductwork accounted for 4,806,000 homes, or 5.1%. Another 11,506,000 homes, or 12.3%, use room heaters, stoves, and fireplaces as principal space heating sources.

In addition to the main heating equipment, another 29,563,000 occupied homes, or 31.6% of the total, use systems or appliances listed among the principal equipment as providers of secondary heat. Most use fireplaces, stoves, or room heaters, but 1,239,000 listed warm-air furnaces; 276,000 listed hydronic systems; 337,000 listed heat pumps; and 2,564,000 use built-in electric systems as secondary heat sources.

Of the total occupied homes, 23,060,000, or 24.6%, listed electricity as the main home space-heating fuel.

Natural gas accounted for 47,395,000 occupied homes, or 50.6% of the total. The fuel oil share was 12,469,000 homes, or 13.3%. And LP gas, with 3,664,000 homes, had a 3.9% share.

Kerosene accounted for 1,073,000 homes, or 1.2%; wood accounted for 4,586,000 homes, or 4.9%; coal for 335,000 homes, or 0.3%; solar for 40,000 homes; and other fuels for 168,000 homes.

It should be noted that 19,839,000 occupied homes, or 21.2% of the total, use more than one fuel. Chief among them were wood and electricity.

FUELS AND ENERGY

As a nation, U.S. energy consumption for the first 10 months of 1991 was 67.54 quadriilion Btu (quads), an increase of 0.17% over the 67.427 quads consumed during the same period in 1990, according to the Energy Information Administration (EIA).

To add some perspective, the nation's energy consumption for the full year of 1990, at 81.269 quads, was only 9.4% higher than the 74.282 quads consumed in 1973, the year of the OPEC oil embargo.

Energy consumption dropped somewhat after 1973, then grew to 78.898 quads in 1979, just after the second major oil price shock. It declined again during the 1982 recession, then built to 80.195 quads in 1988.

In the residential-commercial sector (EIA lumps them together), the 24.463 quads consumed during the first 10 months of 1991 were 1.9% more than the 23.996 quads consumed by this sector in the same period of 1990. The 1990 full-year total of 29.18 quads represented a 20.8% increase over the 24.143 quads used by the residential-commercial sector in 1973.

During the first 10 months of 1991, this sector represented a 36.2% share of total energy consumption. This was up 1% from the same period in 1990, and much higher than the 32.5% share in 1973.

Industrial consumption of 24.619 quads in the first 10 months of 1991 was 0.5% lower than the 24.759 quads consumed by that sector during the same period in 1990. The full-year 1990 total of 29.837 quads was 5.4% less than the 31.528 quads consumed by that sector in 1973.

During the first 10 months of 1991, the industrial sector accounted for a 36.5% share of total energy consumption, almost the same as in 1990. In 1973, the industrial sector consumed 42.4% of the nation's energy.

For the record, the transportation sector consumed 18.419 quads during the first 10 months of 1991, a 1.3% decline from the 18.669 quads consumed during the same period in 1990. It represented a 27.3% share of total energy consumption, about the same as in 1990. The share in 1973 was 25%.

Electric utilities consumed 25.179 quads during the first 10 months of 1991, a 1.5% increase over the 24.806 quads consumed during the same period a year earlier. The 1990 full-year total of 29.582 quads was 49% more than the 19.582 quads consumed by electric utilities in 1973.

Of the 24.463 quads consumed by the residential-commercial sector during the first 10 months of 1991 (with the share for the same period in 1990 in parentheses), only 0.48% (0.51%) were coal; 23.7% (23.9%) were natural gas; 8% (8.6%) were petroleum; 21.3% (21%) were electricity; and 46.5% (46.4%) were electricity generation and transmission losses.

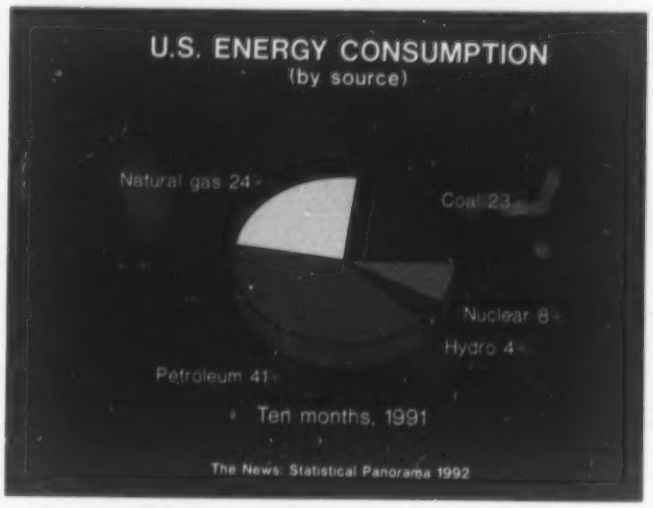
Similarly, the 24.619 quads consumed by the industrial sector during the first 10 months of 1991 breaks down this way: 8.5% (9.2%) were coal; 29.6% (28.8%) were natural gas; 27% (27.5%) were petroleum; 10.9% (10.8%) were electricity; and 23.8% (23.6%) were electricity generation and transmission losses.

Conservation

In order to get a gross measure of conservation, the Department of Energy records show that, in 1973, it took 22,700 Btu to generate each 1987 constant dollar of gross national product (GNP).

In the third quarter of 1991, it took 16,900 Btu to generate a 1987 constant dollar of GNP, or 25.6% less than in 1973. The third quarter of 1991 value was only slightly higher than the 16,600 Btu/dollar of GNP recorded in the third quarter of 1990.

The average price residential customers paid for No. 2 fuel oil, before taxes, was $1.258/gal in October, 1991, according to EIA (Energy Information Administration). That was the same price they paid a year earlier when the Gulf War caused a spike in fuel oil and kerosene (jet fuel) prices.



In simpler terms, the U.S. economy in the third quarter of 1991 produced at a rate of 4.863 trillion constant 1987 dollars' worth of goods and services, with 25.6% greater energy efficiency than in 1973.

Had it not been for that improvement, energy consumption for the first 10 months of 1991 would have been 84.83 quads instead of the actual 67.54 quads.

Fuel costs

The average price residential customers paid for No. 2 fuel oil, before taxes, was $1.258/gal in October, 1991, according to EIA. That was the same price they paid a year earlier when the Gulf War caused a spike in fuel oil and kerosene (jet fuel) prices.

The price of No. 2 fuel oil dropped to a low of 86.4¢/gal last summer.

From the previous peak of $1.194/gal in 1981, fuel oil prices declined gradually to 81.3¢/gal in 1988. Since that time, however, they have been increasing gradually. In 1978, before the second oil price shock, No. 2 fuel oil delivered to homes was only 49¢/gal.

The 10-month average price of natural gas delivered to residential customers in 1991 was $5.92/1,000 cu ft, a 1.4% increase over the $5.84/1,000 cu ft average for the first 10 months of 1990. These prices, according to EIA, include all taxes.

Gas prices reached a peak of $6.12/1,000 cu ft in 1984 and 1985, then declined to $4.63/1,000 cu ft in 1988. Since then, they have moved slowly upward. The 1991 average price was 359% higher than the $1.29/1,000 cu ft charged in 1973.

The average natural gas price charged commercial customers during the first 10 months of 1991 was $4.89/1,000 cu ft, a 1.7% increase over the $4.81/1,000 cu ft charged for the same period a year earlier. The 1991 average was 12.5% lower than the $5.59/1,000 cu ft peak price in 1983, but 420% higher than the 94¢/1,000 cu ft charged in 1973.

The 10-month average cost of natural gas for industrial customers in 1991 was $2.63/1,000 cu ft,

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NCA (National Coal Association) said coal was used to generate 55.1% of the nation's electricity. Coal holds a 55% market share of utility fuel. A new phenomenon, the nonutility generator, is beginning to have an effect on electricity demand from conventional public utilities.

LABOR

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each of the last two years.

Health care

Union contractors in the construction industry will contribute an estimated $5 billion in 1992 to multi-employer health and welfare plans, CLRC reported. It's the single most expensive fringe benefit.

The current construction industry hourly contribution to health and welfare funds is $2.35/hour, an amount that has more than doubled in the last nine years. The health and welfare share of total wages and fringes has increased from just over 6% to just under 10%. Of the average increase of just over $6/hour since 1983, $1.20 has gone into health and welfare funds.

Of the average wage-and-fringe rate of $24.48/hour in 1992, 76.5% went for wages, 9.6% went for health and welfare, 8.3% went for pension contributions, and 5.6% went for other fringes.

The average health and welfare contribution for United Association (UA) plumbers and pipefitters is $2.53/hour, or 9.8%. The average for the Sheet Metal Workers' International Association (SMWIA) is $2.53/hour, or 9.5%.

CLRC said that frequently, in multi-year contracts, increases in the second and third year need to be reallocated to maintain health benefits. And, because many maintain eligibility for some time while unemployed, today's high unemployment rates mean declining fund income and higher claims.

CLRC said the primary reason for lower settlements nationally in 1991 was the drop in average increases for unions in New England, the Middle Atlantic states, and the Southwest Pacific region, where average first-year increases dropped by a minimum of 1.5% from 1990 levels. In 1990 the average first-year increase for these three regions was $1.12/hour; in 1991 it was 84¢.

Regional differences continue to diminish. Only the West North Central region — with the lowest of all increases — was more than 1% from the national average. The large East North Central region was the only one in which the average was above the national average.

Geographic differences appeared to play a larger role than intercraft variations. Six of the 11 crafts with reportable averages had lower percentage increases in 1991 than in the previous year.

CLRC reported that the uncertainty that has accompanied the weakness in the economy has resulted in shorter contract durations.

One-year agreements displaced three-year agreements as the most frequently negotiated and agreements for longer than three years, which began appearing in 1990, were rare. Only in the Middle Atlantic and East North Central regions were there a majority of multi-year agreements.

Of the 456 agreements negotiated in 1991, 412 contained wage increases. Of the total, 210 were one-year agreements; 246 were for more than one year.

UA and SMWIA

Of the 33 contracts negotiated last year by UA pipefitter and pipefitter-plumber locals, the average first-year settlement was 98¢/hour, or 3.9%. Of these, 19 agreements included a second-year average increase of 94¢/hour, or 3.6%.

Of the 35 agreements negotiated by SMWIA locals last year, the average first-year increase was $1.02/hour, or 3.9%. And, unlike the previous year, SMWIA negotiated 19 multi-year agreements with an average second-year increase of 95¢/hour, or 3.8%.

Service rates

Thus far, we have only dealt with union shops, where wage rate information is more readily available. Data for open shops, which account for about 80% of the nation's hvac contractors, is more difficult to obtain.

A survey of *News* readers published Nov. 4, 1991 revealed that the disparity between union and open shop contractors remains strong. Nearly 40% of union contractors pay $30/hour or more, while only 4% of open shop contractors do. At the other end of the spectrum, 18% of nonunion contractors pay $13/hour or less, while only 6% of union contractors do.

Overall, the median basic charge-out rate was $42/hour. The median payroll labor cost (including fringe benefits) was $17.63/hour.

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a 9% decline from the $2.89/1,000 cu ft average for the same period in 1990. The 1991 price was 37.7% lower than the peak price of $4.22/1,000 cu ft charged in 1984, but 426% higher than the 50¢/1,000 cu ft charged in 1973.

The 10-month average cost of electricity for residential customers in 1991 was 8.1¢/kWh, a 2.5% increase over the 1990 average of 7.9¢/kWh for the same period. Electricity prices have risen steadily over the last dozen years, but the increase has been less than 13% since 1983. However, the 1991 average was 224% higher than the 1973 rate of 2.5¢/kWh.

The average price utilities charged commercial customers for the first 10 months of 1991 was 7.5¢/kWh, up slightly from the 7.4¢/kWh charged for the same period a year earlier. The 1991 average was the same as the 1985 rate. The average dipped to 6.9¢/kWh in January, 1989, but climbed thereafter. It was 212% higher than the 2.4¢/kWh charged commercial customers in 1973.

Similarly, the average price paid by industrial customers for the first 10 months of 1991 was 4.9¢/kWh, up a hair from the 4.8¢/kWh average for the same period in 1990. The 1991 price was 5% lower than the peak price of 5.19¢/kWh paid in 1985, but 277% higher than the 1973 average of 1.3¢/kWh.

Nuclear

In October 1991, U.S. nuclear generating units produced a net total of 48 billion kWh of electricity, 10% more than in the same month a year earlier, according to EIA.

Nuclear units generated at an average capacity factor of 64.2%, or 6% more than in October, 1990. Nuclear power supplied 21.4% of the total electric utility-generated electricity last October, up from 19.3% in October, 1990.

As of Oct. 31, 1991, there were 111 operable nuclear generating units in the U.S. with a collective net summer capability of 99.6 million kW of electricity. Of the total, 28 units generated at less than 25% of capacity because of maintenance, refueling, or repair outage. Of those, 19 units generated no electricity during the month.

Four units with full-power licenses have been shut down by the Nuclear Regulatory Commission. Only two nuclear power plants are actively under construction.

Electricity sales

Electricity sales to ultimate customers, at 2,314,953 million kWh for the first 10 months of 1991, were up 1.8% from the year-previous 10-month total of 2,274,773 million kWh. Total sales in 1973 amounted to 1,712,909 million kWh.

Of the 2,366,956 million kWh generated during the first 10 months of 1991 (with comparable 1990 percentages in parentheses), 54.4% (55%) came from coal; 9.7% (9.8%) came from natural gas; 4% (4.4%) came from petroleum; 21.7% (20.4%) came from nuclear units; 9.9% (10%) came from hydroelectric installations; and 0.35% (0.38%) came from other sources.

Of the 2,314,953 million kWh sold in the first 10 months of 1991, residential sales (with a 34.7% share) totaled 803,964 million kWh, up 3.4% from the 777,179 million kWh sold during the same period a year earlier.

Commercial sales (with a 27.8% share) totaled 643,381 million kWh for the 1991 period, up 1.6% from the 633,406 million kWh for the same period in 1990.

Industrial sales (with a 33.9% share) totaled 786,209 million kWh for the 10-month 1991 period, up 0.1% from the 785,109 million kWh for the same period in 1990. Other sales (with a 3.5% share) totaled 81,400 million kWh for the 1991 period, up 2.9% from the 79,079 million kWh total for the same period in 1990.

The net summer generating capability of the electric utility industry at the end of the third quarter of 1991 was 693,350 megawatts (MW), up 0.8% from the net of 687,984 MW at the same time a year carlier, according to the Edison Electric Institute (EEI).

Similarly, the net winter generating capability at the end of the third quarter of 1991 was 705,278 MW, also up 0.8% from the 699,495 MW for the same time a year earlier.

EEI reported that electric utility output in the contiguous 48 states for the 52 weeks ended Dec. 28, 1991 was 2,959,164 million kWh, an increase of 2.3% over the 2,891,442 million kWh recorded for the same period in 1990.

The average number of electric utility customers at the end of the third quarter of 1991 was 110,295,000, up 0.8% from the 109,202,000 total at the same time a year earlier.

The U.S. economy in the third quarter of 1991 produced at a rate of 4.863 trillion constant 1987 dollars' worth of goods and services, with 25.6% greater energy efficiency than in 1973.

Natural gas

Gas utility thermal equivalent sales in 1991 (based on 11 months actual and one month estimated) totaled 9,775.8 trillion Btu, down 0.7% from the 1990 actual total of 9,846.2 trillion Btu, according to the American Gas Association (AGA).

The total for 1991 represents a 22.5% drop from the 1985 total of 12,615 trillion Btu.

Residential sales (46.6% of the total) in 1991 amounted to 4,553.2 trillion Btu, up 1.8% from the 1990 total of 4,471.5 trillion Btu. The residential sector had a 39.4% share in 1986.

Commercial sales (with a 22.6% share) in 1991 amounted to 2,210.1 trillion Btu, up 0.8% from the 1990 total of 2,193.2 trillion Btu. Industrial sales (19% of the total) amounted to 1,857.5 trillion Btu in 1991, down 1.7% from the year-previous total of 1,890.5 trillion Btu. The industrial sector's share of the total was 26% in 1986.

Electricity generation sales (9.9% of the total) in 1991 amounted to 971.2 trillion Btu, down 13.3% from the 1990 total of 1,120.1 trillion Btu. The "other" category (1.9% of the total) accounted for 183.8 trillion Btu in 1991, up slightly from 170.9 trillion Btu in 1990.

AGA reported that the November, 1991 average natural gas utility price was $4.597/million Btu, an increase of 3.1¢/million Btu over the $4.566/million Btu average for the same month of 1990.

Prices for specific markets in November, 1991 (November, 1990 prices in parentheses) averaged $5.656/million Btu ($5.543) for the residential sector; $4.821 million Btu ($4.828) for the commercial sector; $3.069/million Btu ($3.181) for industrial customers; and $2.437/million Btu ($2.609) for electric utilities.

It should be noted that the excess natural gas production capability — the gas "bubble" — that has been a fact of life since 1980 has been virtually eliminated.

During a cold winter, AGA said the gas industry would use all available production, plus storage and imports, to meet demand. The winter of 1991-1992, however, promises to be the warmest on record.

The gas bubble grew steadily from 1980 to a high of 4,176 billion cu ft in 1985, then declined to 223 billion cu ft in 1990. Market growth is only partly responsible for the decline.

AGA reports that reduced drilling activity, coupled with a decline in production per gas well, were other contributing factors.

The 10-month average price of natural gas delivered to residential customers in 1991 was $5.92/1,000 cu ft, a 1.4% increase over the $5.84/1,000 cu ft average for the first 10 months of 1990. These prices, according to EIA, include all taxes.

Exploration

Total oil and gas well completions during the first 11 months of 1991 amounted to 24,890 wells, down 7.9% from the 27,020 wells drilled during the same period in 1990.

Both years were dramatically lower than the 90,030 wells completed in the peak year of 1981.

Oil well completions for the first 11 months of 1991 totaled 10,540, down 0.8% from the 10,630 oil well completions in the same period of 1990. Gas well completions for the first 11 months of 1991 totaled 8,020, down 11.5% from the 9,060 gas wells completed in the same period a year earlier.

The remaining 6,330 were dry wells (down 13.6%) which, at 25.4% of the total, were less than the 31% average for the prior decade.

Total footage drilled during the first 11 months of 1991 amounted to 118,590 million ft, down 7.9% from the total of 129,180 million ft drilled in the same period of 1990.

In 1991, the weekly average of rotary drilling rigs in operation was 860, down 14.7% from the 1990 weekly average of 1,008 rigs. Of the 1991 total, 81 rigs (9.4%) were drilling offshore (down 25%), and 779 rigs (90.6%) were drilling on land (down 13.4%).

The monthly average of crews involved in seismic exploration in 1991 was 104, down 16.8% from the monthly average of 125 crews in 1990. Of the seismic crews in 1991, land crews accounted for 81.7% and offshore crews accounted for 18.3%.

Imports

U.S. net imports of energy for the first 10 months of 1991 totaled 11.018 quads, a decline of 9.9% from the 12.23-quad total for the same period in 1990. This amounts to 16.3% of domestic consumption.

Put another way, the U.S. produced 83.7% of all the energy it consumed during the first 11 months of 1991.

Of the 11.018 net quads for the first 10 months of 1991, crude oil accounted for 10.32 quads, or 93.7%. It was down 4.8% from the 10.843 quads of net petroleum imports for the same period in 1990.

Petroleum products, at 1.482 quads for the first 10 months of 1991, were down 40% from the 1990 same-period total of 2.467 quads. They accounted for 13.5% of total net imports in 1991.

Natural gas net imports for the 11-month 1991 period totaled 1.305 quads (11.8% of the total), a 10.8% decline from the 1990 same-period total of 1.177 quads. And coal, with a net export total of 2.26 quads for the first 11 months of both 1990 and 1991, had a positive effect on the total — and our arithmetic.

Significantly, the U.S. was importing petroleum in the third quarter of 1991 at a rate of 7.168 million barrels/day, or 42.4% of all petroleum products supplied (16.918 million barrels/day). This represents a 4.6% decline from the net import total of 7.512 million barrels/day rate in the third quarter of 1990, which amounted to 43.9% of all petroleum products supplied (17.223 million barrels/day).

Of the 1991 net import rate of 7.168 million barrels/day, the Arab members of OPEC (Organization of Petroleum Exporting Countries) supplied 2.026 million barrels/day, or 12% of total petroleum supplies; other OPEC countries (Ecuador, Gabon, Indonesia, Nigeria, and Venezuela) supplied 4.217 million barrels/day, or 24.9% of total petroleum supplies.

Coal

The U.S. coal industry produced 998 million tons of coal in 1991, down 3% from the record 1.029 billion tons produced in 1990, according to preliminary figures released by the National Coal Association (NCA).

Production this year, however, is expected to increase by 3.1% to equal 1990's record performance.

Total consumption in 1991 equaled the record total of 1.001 billion tons set in 1990. But a 2.5% increase this year could set a new record for consumption of 1.026 billion tons.

The Economics Committee forecast that 1991 domestic consumption will total 892 million tons, down slightly from the 895 million ton total in 1990. Domestic consumption is expected to increase by 2.2% in 1992 to a record 912 million tons.

Electric utilities consumed 776 million tons of coal in 1991, up 0.5% from the 772 million tons consumed by utilities in 1990. Utility consumption is expected to increase by 2.3% in 1992 to 794 million tons.

NCA said coal was used to generate 55.1% of the nation's electricity. Coal holds a 55% market share of utility fuel.

A new phenomenon, the nonutility generator, is beginning to have an effect on electricity demand from conventional public utilities.

This market has grown from 40 million kWh in 1985 to approximately 116 million kWh in 1990, or 4% of electric power generation. It is an especially important factor in the New England, West South Central, and Pacific regions.

Consumption of coking coal, at 34 million tons in 1991, was down 15% from the 40 million-ton total in the previous year because of a 12% drop in domestic steel production. It's expected to grow by 5.9% this year to 36 million tons.

Industrial and retail sales, at 82 million tons in 1991, were down by one million tons from 1990 and expected to stay flat this year.

Coal exports grew by 5.8% in 1991, from 91 million tons in 1990 to 96 million tons last year. Expect a 4.6% improvement in 1992 to 99 million tons because of an expanding world market for both steam and metallurgical coal.

Imports of coke in 1991 totaled one million tons, down from three million tons in 1990. Other imports remained constant at three million tons.

Of the 998 million tons of coal produced in the U.S. last year, 592 million tons (or 59.3%) were produced in the East and 406 million tons (40.7%) were produced in the West.

Production in the East is expected to increase by 2.87% this year to 609 million tons. The expected 3.7% increase in production in the West will bring that total to 420 million tons.